

ED_000545A_00000514

Performance Work Statement

Contract EP-C-07-018	Work Assignment Number 01 Amendment 3
Issuing Office	Environmental Protection Agency 2000 Traverwood Drive Ann Arbor, MI 48105-2498
Contractor	Southwest Research Institute 6220 Culebra Rd. San Antonio, TX 78228-0510
Title	Comprehensive Gasoline Light Duty Exhaust Fuel Effects Test Program to Cover Multiple Fuel Properties and Two Ambient Test Temperatures

Background

Section 1506 of the Energy Policy Act of 2005 (Energy Act) requires EPA to produce an updated fuel effects model representing the 2007 light duty gasoline fleet, including determination of the emissions impacts of increased renewable fuel use.

The use of ethanol in gasoline has increased more than five-fold since 2000, and it is likely that its use will continue to expand into the next decade. It is also likely that use of ethanol blends at 10% or greater will expand significantly.

Recent investigation related to the Mobile Source Air Toxics (MSAT2) rulemaking has shown that hydrocarbon emissions from light duty gasoline vehicles increase significantly as test temperature is decreased. As a result, the MSAT2 rulemaking promulgated NMHC standards at 20°F. However, this being a relatively new area of study, fuel effects data at temperatures lower than 75°F is scarce for use in emissions models.

Hydrocarbon (HC) emissions are composed of hundreds of compounds, some of which have been identified by the EPA as air toxics. The Clean Air Act directs EPA to set standards to reduce air toxics emissions. Most existing data on the fractional relationship between the various air toxics and HC emissions has been established using vehicles meeting Tier 0 emissions standards (now more than 10 years old), and burning fuels that did not contain ethanol.

Scope and Objectives

This Work Assignment (WA) has been designed to fill significant data gaps on fuel effects for the newest-technology (Tier 2) vehicles:

- Multiple levels of ethanol in gasoline shall be examined in this test program, along with ethanol's interactions with other fuel properties, e.g. volatility and distillation parameters.

- Varying levels of aromatics shall also be evaluated, as they continue to be of interest due to their relationship to emissions of air toxics and the formation of particulate matter in the atmosphere.
- A portion of the tests shall be performed at 50°F to fill the gap in the existing data at reduced ambient temperatures.
- Total hydrocarbon (THC), non-methane hydrocarbons (NMHC), non-methane organic gas (NMOG), oxides of nitrogen (NO_x), nitrogen dioxide (NO₂), carbon monoxide (CO), carbon dioxide (CO₂), particulate matter (PM), nitrous oxide (N₂O), ammonia (NH₃) and hydrogen cyanide (HCN) emissions shall be measured in newer (Tier 2) vehicles.
- This program shall also generate speciated volatile organic compound (speciated VOC) data. VOC compounds of interest include C1 – C12 hydrocarbons as well as light alcohols and carbonyls.

The contractor shall perform vehicle preparation and driving tests to generate analytical data on exhaust gas emissions. The contractor shall also generate electronic reports and databases, as well as quality assurance documentation.

Work Requirements

This work assignment requires that the contractor procure 19 suitable test vehicles and 19 test fuels and execute the test program described below.

The contractor shall be responsible for providing engineering, technical, and Quality Assurance (QA) support for this project. Engineering support includes facility design, test plan development, and general oversight of data collection activities. Technical support includes installing and maintaining all instrumentation and support equipment, as well as calibration, testing, and data processing activities. QA support includes reviewing existing standard operating procedures (SOPs), preparing QA documentation, developing miscellaneous operating procedures (MOPs), and reviewing raw and processed data prior to delivery to EPA.

Task 1 Work Plan Development

The contractor shall submit a detailed work plan for EPA approval. The work plan shall include a detailed description of how the tasks described below are to be performed, including details such as toxics measurement methodology. The work plan shall include suggested alternatives for any of the required tests or procedures if such alternatives are thought to result in higher quality results.

This work assignment includes two testing options, A and B, which differ with respect to the degree of test randomization. The work plan costs shall be broken down by task and sub-task for each of these options. The work performed shall be based upon the evaluation of each option presented in the work plan by the EPA Work Assignment Manager (WAM). The work shall proceed only upon the selection of an option by written technical direction from the WAM.

The project work plan shall include descriptions of each task to be accomplished, along with detail on the level of effort, by professional grade, a cost breakdown for each task, and any information on the underlying assumptions used in arriving at these cost estimates. The contractor shall conduct necessary activities to properly and efficiently manage the work assignment, including at least weekly communication with the EPA WAM. The contractor shall also include a list of any facility issues or upgrades that may be needed to implement this work assignment.

This work is projected to cover a period of up to two years. Therefore the work plan must break down costs to indicate what can be reasonably accomplished during this initial contract year.

Task 2 Quality-Assurance Project Plan and Quality Management Plan (QAPP/QMP)

The contractor shall submit a Quality Assurance Project Plan (QAPP) to the EPA Work Assignment Manager for approval. The plan shall detail sample data collection and analysis tasks and procedures for the proposed study. Guidance for QAPP preparation is available at <http://www.epa.gov/quality/qapps.html>. The QAPP shall be approved by the EPA WAM before any work commences.

The Quality-Assurance Project Plan shall specify the procedures required to collect data in a manner consistent with the objectives of the study. The plan will be developed in consultation with the EPA Work Assignment Manager. The QAPP documents shall conform to the EPA ANSI/ASQC E-4 standard and shall contain appendices containing all applicable standard operating procedures (SOPs).

In the QAPP, the contractor shall describe measures designed to ensure data quality, including but not limited to:

- Standard operating procedures for equipment used to perform calibrations.
- Calibration frequency and schedule for all equipment used in testing (analyzers, dynamometer, chemical speciation equipment).
- Procedures for sampling and recruitment.
- Procedures for data transfer, entry and management.
- Procedures for regular transfer of all data generated in this project to the EPA Work Assignment Manager for review/audit, consistent with Task 7.3 of this Statement of Work.

Task 3 Vehicle Recruitment

The contractor shall acquire (through lease, purchase, or alternate recruitment technique approved by the EPA WAM) 19 test vehicles for use in this program. All of these vehicles must be/have been certified and sold as being compliant with the Federal Tier 2 emissions standards, and shall be selected from the vehicles listed in Table 3-1. Of these vehicles, 4 must be flexible-fueled vehicles (FFVs) of differing models capable of operation on ethanol-gasoline blends up to and including 85% ethanol (E85). All test vehicles shall be two-wheel drive and feature an

automatic transmission. Each vehicle shall have a maximum of 20,000 miles on the odometer (exceptions must be approved by the EPA WAM) at the outset of the emissions test program. The vehicles shall be in good operating condition with no engine, transmission, or emission system malfunctions indicated or observed.

Table 3-1 lists the target vehicles for recruitment. In cases where multiple vehicle models are listed for a given model year engine family, any model within that family may be selected. If model year 2007 vehicles are not available, 2008 model year vehicles may be substituted provided that these vehicles are of the same certification levels as indicated for the 2007 model year vehicles listed below or cleaner. If model year 2008 vehicles are selected, the contractor shall submit engine family data to the EPA WAM for confirmation and approval prior to recruiting any vehicles.

Table 3-1. Test Vehicles for Recruitment

Make	Year	Brand	Model	Engine	Family	T2 Bin	Note
GM	2007	Chevrolet	Cobalt/HHR	2.4L I4	7GMXV02.4029	5	
GM	2007	Chevrolet	Impala	3.5L V6	7GMXV03.5052	5	FFV
GM	2007	Buick/GMC/Saturn	Enclave/Acadia/Outlook	3.6L V6	7GMXT03.6151	5	
GM	2007	Chevrolet/GMC	Avalanche	5.3L V8	7GMXT05.3381	4	FFV
Toyota	2007	Toyota	Corolla	1.8L I4	7TYXV01.8BEA	5	
Toyota	2007	Toyota	Camry	2.4L I4	7TYXV02.4BEB	5	
Toyota	2007	Toyota	Sienna	3.3L V6	7TYXT03.3BEM	5	
Toyota	2007	Toyota	Tundra	4.0L V6	7TYXT04.0AEV	5	
Ford	2007	Ford	Focus	2.0L I4	7FMXV02.0VD4	4	
Ford	2007	Ford	500/new Taurus/Freestyle	3.0L V6	7FMXV03.0VED	5	
Ford	2007	Ford/Mercury	Explorer/Mountaineer	4.0L V6	7FMXT04.03DB	4	
Ford	2007	Ford	F150	5.4L V8	7FMXT05.44H2	8	FFV
Chrysler	2007	Dodge	Caliber	2.4L I4	7CRXB0144M80	5	
Chrysler	2007	Dodge/Chrysler	Caravan/Town & Country	3.3L V6	7CRXT03.3NHP	8	FFV

Chrysler	2007	Jeep	Liberty	3.7L V6	7CRXT03.7NE0	5	
Honda	2007	Honda	Civic	1.8L I4	7HNXV01.8MKR	5	
Honda	2007	Honda	Accord	2.4L I4	7HNXV02.4KKC	5	
Honda	2007	Honda	Odyssey	3.5L V6	7HNXT03.5VKR	5	either family
					7HNXT03.5WKR		cylinder deact.
Nissan	2007	Nissan	Altima	2.5L I4	7NSXV02.5G5A	5	

All candidate vehicles recruited by the contractor shall be inspected and prepared for testing according to the methodology outlined in Task 5.

Task 4 Test Fuels and Lubricants

Engine lubricants for this program will be provided by the EPA. They will meet the manufacturer's recommended specifications contained in the owner's manuals. The contractor shall inform the EPA WAM of the volume of lubricant needed in each viscosity grade.

At the outset of the program, the contractor shall take a 1 quart lubricant sample from each drum of lubricant supplied and ship all samples to the laboratory designated by the EPA WAM. The contractor shall take an additional 1 quart lubricant sample from each vehicle immediately following its last emissions test in this program and ship the sample to the same laboratory for analysis. EPA will arrange for sample analysis and provide the contractor with the required shipping information prior to the start of the program.

The contractor shall procure and maintain all test fuels for this program. Detailed specification of these fuels is provided in Appendix A.

The test fuels shall be blended exclusively from refinery components and cuts of refinery components. Special chemicals and chemical blendstocks shall not be used. However, butane and benzene may be used to adjust RVP and benzene content of these fuels, respectively. Furthermore, sulfur content of the fuels may be adjusted using a three-component sulfur mixture containing 4.3 mass % dimethyl disulfide, 22.8 mass % thiophene and 72.9 mass % benzothiophene. All blendstocks used in this program must be approved by the EPA WAM.

All ethanol-containing fuels shall be prepared using denatured ethanol meeting the requirements of ASTM D4806 standard. The properties of all ethanol-containing fuels shall be reported on a total sample basis, e.g. hydrocarbon type content by ASTM D1319 shall be corrected for ethanol content in the fuel. An oxidation inhibitor shall be added to all finished test fuels.

Hand blend inspection data for every test fuel shall be presented to the EPA WAM for review. Final blending shall not proceed unless authorized by the EPA WAM. Similarly, final blend inspection data generated by the blending laboratory (in the event that fuel blending will be subcontracted), and by the contractor, shall be forwarded to the EPA WAM for review prior to the shipment of these fuels for use in this test program. The shipment of the fuels to the contractor and their use in this program shall not proceed unless authorized by the EPA WAM. Once a fuel has been accepted for testing, a 5 gallon sample shall be shipped to EPA for use in an audit and/or a round robin program.

The contractor shall make sure that the quantities of test fuels blended include a reasonable safety margin in case some of the tests must be repeated and shall advise the EPA WAM about the magnitude of that margin. In addition, the blending subcontractor (if any) shall prepare 200 gallons (each) of fuels 17, 18, and 19 beyond what is needed for this program. The additional quantities of these fuels shall be shipped to EPA's facility in Ann Arbor, Michigan, when directed by the WAM.

Upon the receipt of test fuels, the contractor shall conduct a limited set of analyses (to be determined) on a single drum sample of each fuel. Additional analyses (to be determined) shall be conducted on a single drum sample of each fuel at the midpoint and at the end of the program to determine if any fuel properties have changed as a result of fuel storage and handling.

The contractor shall utilize fuel storage and handling practices that will minimize, to the greatest extent possible, any changes in test fuel properties or mislabeling of fuel drums, or any other possible situations which could lead to misfueling of the test vehicles. These practices shall include the storage of test fuels in sealed 5B drums, indoors, at temperatures not exceeding 75°F. Furthermore, to assure that no drums are mislabeled, the contractor shall confirm fuel properties using a Petrospec analyzer each time a new drum is opened. Additionally, unique alphanumeric labels assigned to individual drums shall be recorded each time a vehicle is fueled.

Similarly, the contractor shall ensure that the fuel blending subcontractor (if any) will apply equally stringent fuel storage and handling practices to finished test fuels waiting for shipment. The contractor shall describe the methods to be employed to minimize such changes, and recommend additional methods that would prevent changes in fuel properties during the test program.

Task 5 Vehicle Preparation

Vehicles shall undergo a thorough inspection before beginning the test preparation sequence. This includes inspection of the engine, transmission, axles, exhaust system and tires, and verification that no OBD2 faults are set. The contractor shall collect and record vehicle information described in Appendix C for entry into MSOD data tables.

Following the inspection, a single FTP test shall then be performed using a baseline fuel (TBD) with bag measurements of THC, NMHC, NO_x, CO, and PM emissions. The results of this initial test shall be submitted to the EPA WAM for review to determine the vehicle's acceptability as a

candidate vehicle for the test program. If accepted by EPA, an approved candidate vehicle may begin mileage accumulation and/or preparations for testing as outlined below.

Each vehicle approved by the EPA WAM shall then undergo initial crankcase oil, oil filter and air filter replacement. Air filters shall only be replaced in used vehicles (vehicles with more than 4,000 odometer miles). Oil and air filters shall be procured by the contractor per manufacturer's recommendations. One of the EPA-supplied lubricants shall be used per the vehicle manufacturer's viscosity requirements.

If the procured vehicle is used (has more than 4000 miles on the odometer), the engine oil and oil filter shall be replaced a second time following a full engine warm-up. The lubricant level in the sump shall be allowed to stabilize and its level indicated on the dipstick shall be recorded. The vehicle shall then be driven 500 miles on non-oxygenated, commercial, 87 octane gasoline to condition the lubricant in preparation for the emissions test program. Mileage accumulation shall either be done on a chassis dynamometer using the Standard Road Cycle or the vehicle shall be driven primarily on local interstates at or below posted speed limits.

If the procured vehicle is new (less than 4,000 miles), it shall be driven to 4,000 odometer miles either by operating it on a mileage accumulation dynamometer using the Standard Road Cycle or the vehicle shall be driven primarily on local interstates at or below posted speed limits. The fuel shall be a non-oxygenated, commercial, 87 octane gasoline. At a predetermined odometer reading (to be provided by the EPA WAM), crankcase oil and oil filter shall be replaced a second time. The lubricant level in the sump shall be allowed to stabilize and its level indicated on the dipstick shall be recorded. Mileage accumulation will then resume and continue until odometer reading of 4,000 miles is attained.

After the last test of each vehicle in the program, the contractor shall record the lubricant level indicated on the dipstick before collecting a 1 quart oil sample for analysis as described in Task 4, above.

Following mileage accumulation and lubricant conditioning, each new vehicle shall once again undergo thorough inspection of the engine, transmission, axles, exhaust system and tires, and verification that no OBD2 faults are set. Used vehicles need not undergo this inspection a second time.

If any test vehicle is equipped with traction control, the contractor shall ensure that the latter is disabled either through an interior disable button or other method (remove power fuse to anti-lock brake system (ABS)), and place a placard in the vehicle indicating the method of disabling traction control if driver input is required. The vehicle shall use a 75°F road load horsepower setting derived from the coastdown coefficients as proposed by the contractor and approved by the EPA WAM. For the purpose of this study, the agreed road load setting shall remain the same for all testing on a given vehicle including the cold temperature testing.

Task 6 Vehicle Testing

6.1 Basic Testing Protocol

The basic testing protocol is the testing of the recruited vehicles across all the test fuels over the California Unified Cycle (LA92) as a three phase, cold start test at FTP ambient and load conditions. Limited testing shall also be done at 50°F. All tests on a given vehicle must be done using the same 48-inch single roll (or equivalent) electric chassis dynamometer. More than one such dynamometer may be used in this program. The same driver shall also be used for all tests on a given vehicle (for all test repeats and across all test fuels). The contractor may comment on the feasibility of these requirements and propose additional measures that will reduce test to test variability, such as multi-shift testing on fewer chassis dynamometers.

During tests performed at FTP ambient conditions, intake air temperature and humidity shall be maintained at $75\pm 2^{\circ}\text{F}$ and 75 ± 5 grains $\text{H}_2\text{O}/\text{lb}$ dry air, respectively. During tests performed at 50°F, intake air temperature shall be maintained at $50\pm 2^{\circ}\text{F}$. The contractor shall recommend the intake air humidity setting and tolerance for 50°F emission tests which must be approved by the WAM before 50°F testing can begin.

Option A

The order in which the various test fuel and vehicle combinations are to be tested shall be randomized. However, replicate tests of a given fuel in a particular vehicle shall be done back-to-back. Specifically, the vehicle shall be tested twice (3 times if determined necessary per emissions variability criteria provided in Table 6.1-3 below) on a given fuel before moving on to the next test fuel in the matrix. This “back-to-back” testing eliminates the need to repeat additional vehicle preps (steps 1-6 of Table 6.1-1, below) between each replicate test on a given fuel.

Option B

As a contrast to Option A, this Option requires the contractor to perform all exhaust emission tests on a given vehicle, even the replicates, in a random order. This will require more frequent vehicle preps between fuel changes but may result in a more preferable experimental design from a statistical point of view.

The emission test program shall be executed in the following sequence:

Phase 1: Fuels 17, 18 and 19 tested in all vehicles at 75°F

Phase 2: Fuels 17, 18 and 19 tested in all vehicles at 50°F

Phase 3: Fuels 1-16 tested in all vehicles at 75°F

The EPA requests that Phase 1 test results be made available as early as possible in the second quarter of 2008. The contractor shall comment on the feasibility of launching and completing Phase 1 of this program in the most expeditious manner.

While it is preferable that Phase 2 of this program be completed immediately following Phase 1, it may also be carried out, as a block, shortly following the launch of Phase 3.

The sequence of events for the testing of an individual vehicle is summarized in Tables 3a and 3b. All vehicles shall be tested two or three times on each fuel at each test temperature (replicate tests). The need for a third test will be determined based on the variability of the previous two replicates (see step 14 in Table 6.1-1, below).

The emissions to be measured and reported are THC, NMHC, NMOG, NO_x, NO₂, CO, CO₂, ethanol, PM, speciated VOCs, N₂O, NH₃ and HCN. The contractor shall comment on the feasibility and cost of incorporating bag (phase) level measurement of ethanol emissions by means of INNOVA photoacoustic analyzer.

More specifically, the following exhaust emission measurements shall be made:

1. Bag (phase) level and composite THC, NMHC, NMOG, CO, CO₂, NO_x, NO₂, ethanol and PM emissions
2. Bag (phase) level speciated VOCs for a subset of tests (See Task 6.2, below). The list of compounds to be measured and analyzed is given in Appendix D
3. Continuous and integrated by bag (phase) emissions of the following species in raw exhaust: THC, NMHC, CO, CO₂ and NO_x
4. Continuous and integrated by bag (phase) emissions of the following species measured in raw exhaust for a subset of tests (see Task 6.3.2, below): N₂O, NH₃ and HCN

In addition, the contractor shall report bag (phase) level and total test cycle work measured at the wheels.

The contractor shall acquire all available data from the vehicle's onboard diagnostic (OBD) system during all emissions tests using contractor-supplied data acquisition equipment. The contractor shall comment on the feasibility of this requirement and the capability of the available data acquisition equipment to meet this requirement.

The facilities for testing shall meet the requirements of 40 CFR Part 86 Subpart B and 40 CFR Part 86 Subpart C as they apply to vehicle exhaust testing. THC, NMHC, NMOG, NO_x, NO₂, CO, and CO₂, and PM emissions sampling and measurement shall be conducted as specified in 40 CFR 1065. The minimum detection limit for NO₂ measurements shall be 5 ppb. If some aspect of testing will need to be done in variance to the above specifications the contractor shall describe why that is the case and how it may impact the test results. Variances must be approved the EPA WAM before testing may begin. The methodology to be used for determining NMHC and NMOG emissions is described in the CARB document "California Non-Methane Organic Gas Test Procedures¹"

The contractor shall recommend sample collection and analytical methods for non-standard emission measurements. These recommendations will take into account analytical detection limits, emission rates expected of Tier 2 vehicles and the requirement to collect all samples in the course of a single LA92 test. All sample collection and analytical methods related to non-standard emission measurements must be approved by the EPA WAM.

6.1.1 Fuel Change and Test Execution Sequence

Option A

Under this Option the contractor shall follow the fuel change and test execution sequence as described in Table 6.1-1, below. The first two emission tests on a given vehicle and fuel combination shall be performed back-to-back. The second replicate shall be run the same way as the first except that only THC, NMHC, NMOG, CO, CO₂, NO_x, NO₂, ethanol (by INNOVA or similar analyzer, if available) and PM emissions shall be measured in dilute exhaust as well as THC, NMHC, CO, CO₂ and NO_x measured continuously in raw exhaust. If the difference between CO₂, NO_x or NMHC results in any set of two replicates is greater than the variability criteria listed in Table 6.1-3, a third replicate shall be run the same way as the second.

Table 6.1-1. Fuel Change and Test Execution Sequence for Option C

Step	Description
1	Drain vehicle fuel completely via fuel rail whenever possible
2	Turn vehicle ignition to RUN position for 30 seconds to allow controls to allow fuel level reading to stabilize. Confirm the return of fuel gauge reading to zero
3	Fill fuel tank to 40% with next test fuel in sequence. Fill-up fuel must be at the temperature of the next LA92 test (75 or 50°F)
4	Start vehicle and execute catalyst sulfur removal procedure described in Appendix C of CRC E-60 Program report
5	Drain fuel and refill to 40% with test fuel. Fill-up fuel must be at the temperature of the next LA92 test (75 or 50°F)
6	Start vehicle and drive one LA4 cycle. Allow vehicle to idle in park for 2 minutes before engine shut-down
7	Move vehicle to soak area without starting or driving
8	Park vehicle in soak area at proper temperature (75 or 50°F) for 12-36 hours
9	Move vehicle to test area without starting engine
10	Perform LA92 cycle emissions test
11	Park vehicle in soak area of proper temperature for 12-36 hours
12	Move vehicle to test area without driving

13	Perform LA92 emissions test
14	Determine whether third replicate is necessary, based on data variability criteria (see Table 6.1-3 below)
15	If a third replicate is required, repeat steps 10, 11 and 12
16	If third replicate is not required, return to step 1 and proceed with next fuel in test sequence

Option B

Under this Option all emissions tests, including replicate tests shall be fully randomized, as described in Table 6.1-2 below. All replicates on a given fuel shall be run the same way as the first emissions test except that only THC, NMHC, NMOG, CO, CO₂, NO_x, NO₂, ethanol (by INNOVA or similar analyzer, if available) and PM emissions shall be measured in dilute exhaust as well as THC, NMHC, CO, CO₂ and NO_x continuously in raw exhaust. If the first two emission tests performed on a given fuel do not meet the variability criteria listed in Table 6.1-3, a third replicate shall be run the same way as the second.

Table 6.1-2. Fuel Change and Test Execution Sequence for Option D

Step	Description
1	Drain vehicle fuel completely via fuel rail whenever possible
2	Turn vehicle ignition to RUN position for 30 seconds to allow fuel level reading to stabilize. Confirm the return of fuel gauge reading to zero
3	Fill fuel tank to 40% with next test fuel in sequence. Fill-up fuel must be at the temperature of the next LA92 test (75 or 50°F)
4	Start vehicle and execute catalyst sulfur removal procedure described in Appendix C of CRC E-60 Program report
5	Drain fuel, and refill to approximately 40% with test fuel. Fill-up fuel must be at the temperature of the next LA92 test (75 or 50°F)
6	Start vehicle and drive one LA4 cycle. Allow vehicle to idle in park for 2 minutes before engine shut-down
7	Move vehicle to soak area without starting or driving
8	Park vehicle in soak area at proper temperature (75 or 50°F) for 12-36 hours
9	Move vehicle to test area without starting engine
10	Perform LA92 emissions test
11	Return to step 1 to prepare for next fuel under the fully randomized test schedule

Each vehicle shall be tested at least twice on a given fuel regardless of option selection. After two tests have been completed and the acquired data has passed all quality control verifications as described in the contractor's QAPP, the need for a third test shall be determined by following the variability criteria shown in Table 6.1-3:

Table 6.1-3. Variability Criteria for Triplicate Testing

Dilute Gaseous Emission	Criteria for requiring a third test (composite cycle emissions)
CO ₂	Ratio of higher / lower > 1.04
NO _x	Ratio of higher / lower > 1.81
NMHC	Ratio of higher / lower > 1.67

If the ratio of any of the above pollutants on a pair of tests on a given vehicle and fuel combination exceeds the levels shown in Table 6.1-3, the contractor shall proceed with the third test and promptly notify the EPA WAM, making available the electronic summary reports of the tests in question.

6.2 Speciation of Volatile Organic Compounds (VOCs)

VOC speciation shall include C1-C12 hydrocarbons as well as light alcohols, and carbonyls. Sampling and analysis of C2-C12 hydrocarbons will be done using CARB method 1002/1003, "Procedure for the Determination of C2-C12 Hydrocarbons in Automotive Exhaust Samples by Gas Chromatography". Sampling and analysis of carbonyl compounds will be done using CARB method 1004, "Determination of Aldehyde and Ketone compounds in Automotive Source Samples by High Performance Liquid Chromatography". Analysis of C1 – C4 HC samples shall be done within one hour of completion of the emissions test. Subsequent analysis of the additional compounds of interest shall be done within 4 hours of emission test completion. The time between sample collection and the start of C1-C4 HC analysis shall be reported. The VOCs to be analyzed are identified in Appendix D. The contractor shall comment on the feasibility of these requirements and propose additional measures to improve the precision of VOC speciation. All methods used in the measurement of VOCs must be approved by EPA WAM.

In Phases 1 and 3 of the program, VOC speciation shall be performed for all 3 test phases of the LA92 cycle, on all fuels (3 fuels in Phase 1 and 16 fuels in Phase 3), for a subset of 3 vehicles (vehicles to be selected by the EPA WAM). This includes all repeat tests, and is outlined graphically in Table 6.2-1, below.

Table 6.2-1: VOC Speciation Summary for 3 Vehicles in Program Phases 1 and 3

LA92 Test Phase (bag)	LA92 Test Repeat		
	1	2	3

1	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls
2	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls
3	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls	C1-C12 Speciation Alcohols Carbonyls

The remaining 16 vehicles shall only require VOC speciation in phase 1 of the LA92 test, also for all test fuels (3 fuels in Phase 1 and 16 fuels in Phase 3). This shall be performed for only one test on each fuel/vehicle combination - no repeat VOC speciations are required. During all repeat tests conducted on these 16 vehicles in Phases 1 and 3 of the program only light alcohols and carbonyls shall be measured and no hydrocarbon speciation shall be done. This is outlined graphically in Table 6.2-2, below.

Table 6.2-2: VOC Speciation Summary for 16 Vehicles in Program Phases 1 and 3

LA92 Test Phase (bag)	LA92 Test Repeat		
	1	2	3
1	C1-C12 Speciation Alcohols Carbonyls	Alcohols Carbonyls	Alcohols Carbonyls
2	none	none	none
3	none	none	none

In Phase 2 of this test program, hydrocarbon speciation shall not be done. However, light alcohols and carbonyls shall be measured in all 3 phases of the LA92 test cycle, on all 3 fuels, for a subset of 3 vehicles (vehicles to be selected by the EPA WAM). The remaining 16 vehicles shall only require the measurement of light alcohols and carbonyls in phase 1 of the LA92 cycle, also on all 3 test fuels. This shall be done for all repeat tests in Phase 2. The VOC speciation summary for Phase 2 of the program is outlined in Tables 6.2-3 and 6.2-4, below.

Table 6.2-3: VOC Speciation Summary for 3 Vehicles in Program Phase 2

LA92 Test Phase (bag)	LA92 Test Repeat		
	1	2	3
1	Alcohols Carbonyls	Alcohols Carbonyls	Alcohols Carbonyls

2	Alcohols Carbonyls	Alcohols Carbonyls	Alcohols Carbonyls
3	Alcohols Carbonyls	Alcohols Carbonyls	Alcohols Carbonyls

Table 6.2-4: VOC Speciation Summary for 16 Vehicles in Program Phase 2

LA92 Test Phase (bag)	LA92 Test Repeat		
	1	2	3
1	Alcohols Carbonyls	Alcohols Carbonyls	Alcohols Carbonyls
2	none	none	none
3	none	none	none

The contractor shall also provide a separate cost estimate for performing hydrocarbon speciation in Phase 2 of this program for all three phases of the LA92 cycle, on all 3 fuels, for a subset of 3 vehicles, and only in phase 1 of the LA92 cycle for the remaining 16 vehicles, also for all 3 fuels. This would include repeat tests as well, and is analogous to Tables 6.2-3 and 6.2-4, above, by adding “C1-C12 Speciation” to all “Alcohols and Carbonyls” entries.

The CARB procedure for calculating NMHC and NMOG (mentioned above and referenced at the end of this document) shall be followed. Phase-level NMOG shall be calculated for all phases where the required measurements are available (i.e. NMHC, carbonyls, and light alcohol measurements are made). In cases where one or more components of the phase-level NMOG calculation is not measured (for example, when carbonyls are not measurement in phases 2 and 3 of some tests) the contractor shall calculate phase-level NMOG mass emissions assuming the missing measurements are below method detection limits. These phase-level NMOG calculations shall then be used to calculate composite weighted NMOG mass emissions. In all cases, the contractor shall report all measured phase-level NMOG components (i.e. each compound quantified) separately along with the associated FID response factors used in NMOG and NMHC determination.

6.3 Continuous Measurements of Gaseous Emissions in Raw Exhaust

6.3.1 Continuous THC, NMHC, CO, CO₂ and NO_x

Continuous and integrated by bag (phase) emissions of THC, NMHC, CO, CO₂ and NO_x shall be measured in raw exhaust. The continuous measurements shall be made at a minimum sampling frequency of 1 Hz. A direct raw exhaust flow measurement device, such as SEMTECH EFM made by Sensors Inc. (or equivalent), shall be used. The contractor shall

comment on the availability of test cells with this capability and propose methods for continuous raw emissions data alignment. The contractor shall provide sample test data illustrating the agreement between the CVS and raw exhaust measurements of THC, CO, NO_x and CO₂ achievable in their laboratory using Tier 2 vehicles, including an assessment of measurement uncertainty for each method.

These measurements shall be performed during the first test of each fuel/vehicle combination in Phases 1, 2 and 3 of the test program. No repeat measurements are required.

6.3.2 Continuous N₂O, NH₃ and HCN

Continuous and integrated by bag (phase) emissions of N₂O, NH₃ and HCN shall be measured using Fourier Transform Infrared Spectroscopy (FTIR) or an alternate method proposed by the contractor and approved by the EPA WAM.

The measurements of N₂O, NH₃ and HCN emissions shall only be done in Phase 1 of the program, during the first test of each fuel/vehicle combination. No repeat measurements are required.

Task 7 Deliverables

7.1 Weekly Reports

The contractor shall provide 30-60 minute telephone conference reports weekly that summarize progress to date. Weekly test results in spreadsheet form shall be provided to the EPA WAM.

The oral report shall indicate progress achieved in the preceding week, technical issues encountered, solutions to issues (proposed or attempted), and projected activity in the following week. This report shall include any potential issues or circumstances that arise causing any delays in the testing. The WAM or his/her designated alternate shall participate in these phone conferences.

7.2 Monthly Written Progress Reports

The contractor shall provide monthly progress reports with invoices. The reports shall track percentages of hours used in each task and whether the project is on schedule. The contractor shall explain problems encountered including resolutions and indicate if the schedule or budget was compromised.

The reports shall summarize the progress made during the reporting month, technical issues encountered, solutions to issues (proposed or attempted), and projected activity in the following month. Graphical presentations shall be made to display results if data has been collected.

7.3 Data Files

The contractor shall submit the data to EPA in three formats, each format having different levels of post processing and aggregation. The files are nominally:

1. Non-Post processed data files (raw data): These are the native test level data files, usually generated by instrumentation, that have not been post-processed for such purposes as time-series alignment or calculation of continuous emission rates. They shall be submitted to EPA as a deliverable for this work assignment and labeled using the following convention:

‘e’<VehID>_<fuelID>_raw.<extension>

where *VehID* is the unique identifier designated for vehicle, *fuelID* is the unique identifier assigned to each fuel type, and *extension* is the appropriate file extension for the file’s data format. Modifications to the specified file-naming convention may be adopted following approval from the EPA Work Assignment Manager.

2. Post processed data files: These are the minimally processed test level data files that will contain the composite, test level, bag level, and 1 Hertz (modal) emission rates in the units specified in 40 CFR Part 86. They shall be submitted to EPA as a deliverable for this work assignment and labeled using the following convention:

‘e’<VehID>_<fuelID>_pst.<extension>

where *VehID* is the unique identifier designated for vehicle, *fuelID* is the unique identifier assigned to each fuel type, and *extension* is the appropriate file extension for the file’s data format. Modifications to the specified file-naming convention may be adopted following approval from the EPA WAM.

3. The contractor shall also deliver Mobile Source Observation Database (MSOD) input data files containing test results and vehicle information using table names, structures, field names and field formats as specified in Appendix C. During the program it may be necessary to design and apply new data types, tables and structures. As necessary, such modifications to the data structure may be proposed by the contractor and approved by the EPA WAM. The contractor shall inform the EPA WAM if they believe the specified precision for a given field(s) is inadequate or inappropriate. The WAM and the contractor shall then determine what changes in the format may be necessary to accurately store the data for future use in MSOD.

The contractor shall include in the work plan prototype electronic versions of the above three file types for the inspection and approval of the EPA WAM.

7.4 Mode of Delivery

The contractor shall deliver one set of files to the EPA WAM at the USEPA National Vehicle and Fuel Emissions Laboratory at Ann Arbor, Michigan.

The contractor shall deliver the data contained in the MSOD formatted tables via a secure method to be proposed by the contractor and approved by the WAM. Under no circumstances shall the contractor deliver these files by insecure methods such as electronic mail attachments or First Class Mail.

7.5 Draft Final Report

The contractor shall develop a draft final report that details the work completed including any issues encountered and results from Tasks 1 through 7.

The draft report shall be submitted to EPA that includes:

- 1) Recruitment procedures
- 2) Vehicle-related information, VIN, mileage, emission system descriptions, etc.
- 3) Measurement methodologies and quality measures
- 4) Test completion diary for individual vehicles detailing any relevant information regarding completion of each test
- 5) All data collected in Tasks 1 through 7 of this work assignment. Graphical displays summarizing the data by fuel type and other relevant breakdowns

The draft final report shall be delivered to EPA within six weeks of the testing completion.

7.6 Final Report

The contractor shall provide a final report incorporating EPA comments, within 30 days of receiving comments from EPA. The report shall be in hard copy plus an agreed-upon electronic format. Microsoft Word or Adobe portable document files (*.pdf) are acceptable formats.

Schedule of Deliverables

Steps	Duration	Completion Date
Conference call to address outstanding issues	As required	December 18, 2007
Project work plan submission	2 weeks	December 18, 2007
EPA reviews and approves work plan	1 week	December 21, 2007
Draft QAPP		January 23, 2008
EPA reviews and approves draft QAPP		February 6, 2008
Vehicle Recruitment	as required for test schedule sequence	
Vehicles accepted by EPA shall begin testing on a rolling basis		First week April 2008

Fuel Acquisition	as required for test schedule sequence	
324 vehicle tests completed, end of current work assignment		June 21, 2008
All Emissions Testing Completed for Test Program	33 weeks (assume April 1st test start date)	November, 2008
Data Delivery	Ongoing as tests completed (incl. replicates)	December 19, 2008
3 versions of formatted data for each veh/fuel ID	5 working days	
Draft Report		January 1, 2009
Final Report	30 days after EPA comments	March 2009
Work Assignment Manager (WAM)	Constance Hart, 734/ 214-4340	
Alternate WAM	Carl Scarbro, ASD 734/214-4209	
Technical Contacts	Aron Butler, ASD 734/214-4011 Michael Christianson, ASD 734/214-4624 Antonio Fernandez, ASD 734/214-4431 Rafal Sobotowski, ASD 734/214-4228	

¹ "California Non-Methane Organic Gas Test Procedures". Amended version, July 30, 2002. Available online at the California Air Resources Board website:
http://www.arb.ca.gov/msprog/levprog/cleandoc/clean_nmogtps_final.pdf.